

1604 Rec'd PCT/PTO 29 JUN 2001

FORM PTO-1390
(REV. 11-2000)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

**TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371**

ATTORNEY'S DOCKET NUMBER

KC-0052

U.S. APPLICATION NO. (If known, see 37 CFR 1.5)

09/869580

INTERNATIONAL APPLICATION NO.
PCT/GB99/04391

INTERNATIONAL FILING DATE
December 30, 1999

PRIORITY DATE CLAIMED
December 31, 1998

TITLE OF INVENTION

PLASTIC STRETCHING METHOD AND APPARATUS FOR USE IN VACUUM FORMING TECHNIQUES

APPLICANT(S) FOR DO/EO/US

Iain PRESTON and Gordon HALL

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. ☐ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☒ is attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ has been communicated by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
 - a. ☐ is attached hereto.
 - b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☒ are attached hereto (required only if not communicated by the International Bureau).
 - b. ☐ have been communicated by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A **FIRST** preliminary amendment.
14. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☐ Other items or information:

00569860

U.S. APPLICATION NO. (37 CFR 1.53) 09/869580		INTERNATIONAL APPLICATION NO.	
		ATTORNEY'S DOCKET NUMBER	

21. <input type="checkbox"/> The following fees are submitted: BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)): Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO. \$1000.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO \$860.00 International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$710.00 International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) \$690.00 International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) \$100.00 ENTER APPROPRIATE BASIC FEE AMOUNT =			CALCULATIONS PTO USE ONLY <table style="width: 100%; border: none;"> <tr> <td style="width: 60%; border: none;">\$ 860.00</td> <td style="width: 40%; border: none;"></td> </tr> </table>		\$ 860.00		
\$ 860.00							
Surcharge of \$130.00 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).			<table style="width: 100%; border: none;"> <tr> <td style="width: 60%; border: none;">\$ 0</td> <td style="width: 40%; border: none;"></td> </tr> </table>	\$ 0			
\$ 0							
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE				
Total claims	2 - 20 =	0	x \$18.00				
Independent claims	14 - 3 =	0	x \$80.00				
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ \$270.00				
TOTAL OF ABOVE CALCULATIONS =			\$ 860.00				
<input checked="" type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.			<table style="width: 100%; border: none;"> <tr> <td style="width: 60%; border: none;">+ \$-430.00</td> <td style="width: 40%; border: none;"></td> </tr> </table>	+ \$-430.00			
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SUBTOTAL =			\$ 430.00				
Processing fee of \$130.00 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).			<table style="width: 100%; border: none;"> <tr> <td style="width: 60%; border: none;">\$ 0</td> <td style="width: 40%; border: none;"></td> </tr> </table>	\$ 0			
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TOTAL NATIONAL FEE =			\$ 0				
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property +			<table style="width: 100%; border: none;"> <tr> <td style="width: 60%; border: none;">\$ 0</td> <td style="width: 40%; border: none;"></td> </tr> </table>	\$ 0			
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TOTAL FEES ENCLOSED =			\$ 430.00				
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charged:	\$						

a. ☒ A check in the amount of \$ 430.00 to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of \$ _____ to cover the above fees.
 A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any
 overpayment to Deposit Account No. 16-0607. A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card**
information should not be included on this form. Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR
 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Fleshner & Kim, LLP
 14500 Avion Parkway
 Suite 125
 Chantilly, Virginia 20151
 (703) 502-9440

 SIGNATURE
 John C. Eisenhart

 NAME
 38,128

 REGISTRATION NUMBER

09/869580

JC18 Rec'd PCT/PTO 2 9 JUN 2001

Docket No.: KC-0052

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of :
Iain PRESTON and Gordon HALL :
Serial No. New U.S. Patent Application :
Confirm. No.: Unassigned :
Filed: June 29, 2001 :
For: PLASTIC STRETCHING METHOD AND APPARATUS FOR USE IN :
VACUUM FORMING TECHNIQUES :

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D. C. 20231

Sir:

Prior to initial examination of the above-identified application, please amend the application as follows:

IN THE CLAIMS:

- A. Please cancel claims 1-14 without prejudice or disclaimer.
- B. Please add new claims 15-28 as follows:

15. (New) A machine for stretching and vacuum forming a rectangular sheet of plastic material, the machine having a first and second orthogonal pairs of opposed elongate clamping means (1-4) which engagably co-operate with the sides of said sheet and thereby hold said sheet, wherein the elongate clamping means (1-4) comprise primary clamping means (13,14) and secondary clamping means, with the primary clamping means (13,14) engagably and fixedly clamping a side of the sheet of the plastic material and the secondary clamping means (5) engagably clamping a portion of the edge of the rectangular sheet of plastic and being adapted to move along the length of the elongate clamping means (1-4), the machine including a means to controllably urge apart a first pair of opposed elongate clamping means (1 and 3) and thereby stretch a sheet held there between characterised in that the second pair of opposed elongate clamping means (2 and 4) uses the movable secondary clamping means (5) to allow said sheet to stretch uniformly in a direction parallel to the lengths of the second pair of elongate clamping means (2 and 4) whilst resisting movement of the clamped sides of the sheet in a direction orthogonal to the lengths of the second pair of elongate clamping means (2 and 4), and once the plastic sheet has been stretched the fixed primary clamping means (13,14) are then used to hold the plastic sheet in a fixed position during the vacuum forming process.

16. (New) A machine for stretching and vacuum forming a rectangular sheet of plastic material as claimed in Claim 15, the machine including means to controllably urge apart both pairs of opposed elongate clamping means (1-4) and thereby stretch a sheet held therein in two dimensions, each elongate clamping means (1-4) using the secondary clamping means (5) to allow said sheet to stretch uniformly in a direction parallel to the length of said individual elongate clamping means (1-4) whilst resisting movement of the side of the rectangular sheet clamped by said individual elongate clamping means (1-4) in a direction orthogonal to the length of said individual elongate clamping means(1-4).

17. (New) A machine for stretching and vacuum forming a rectangular sheet of plastic material, as Claimed in Claim 15, the machine being adapted to stretch the sheet first in one direction and then subsequently in a second direction orthogonal to the first direction.

18. (New) A machine for stretching and vacuum forming a rectangular sheet of plastic as claimed in Claim 15, wherein the secondary clamps are moved along the length of the elongate clamping means by the motion of the sheet.

5

(b) (i) stretching said sheet along a first axis of said sheet whilst holding the sides of said sheet parallel to the first axis so as to allow the sheet to stretch proportionately along the first axis but so as to resist deformation of the sides of said sheet orthogonal to the first axis; and

10

(c) fixedly holding the sides of said stretched sheet using fixed clamping means; and

(d) vacuum forming said stretched sheet.

23. (New) A method of stretching and vacuum forming a rectangular sheet of plastic material as claimed in Claim 22, the method further having the step of: (b) (ii) stretching said sheet along a second axis of said sheet whilst holding the sides of said sheet parallel to the second axis so as to allow the sheet to stretch proportionately along the second axis but so as to resist deformation of the sides of said sheet orthogonal to the second axis, the second axis being orthogonal to the first axis.

24. (New) A method of stretching and vacuum forming a rectangular sheet of plastic material as claimed in Claim 22, the method involving, simultaneous to stretching said sheet parallel to a first axis, also stretching said sheet along a second axis of said sheet whilst holding the sides of said sheet parallel to the second axis so as to allow the sheet to

5 stretch proportionately along the second axis but so as to resist deformation of the sides of said sheet orthogonal to the second axis, the second axis being orthogonal to the first axis.

25. (New) A method of stretching and vacuum forming a rectangular sheet of plastic material as claimed in Claim 22 wherein the secondary clamps are adapted to move along the length of the elongate clamping means (1-4) proportionately to the stretching of the sheet along an axis parallel to the clamping means.

26. (New) A method of stretching and vacuum forming a rectangular sheet of plastic material as claimed in Claim 25 wherein the secondary clamps are moved along the length of the elongate clamping (1-4) means by the motion of the sheet.

27. (New) A method of stretching and vacuum forming a rectangular sheet of plastic material as claimed Claim 22, the method further having the step of heating the sheet of plastic material.

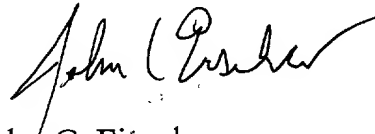
28. (New) A method of stretching and vacuum forming a rectangular sheet of plastic material as claimed in Claim 22 wherein zones of the plastic material are selectively cooled.

T06320-0859360

REMARKS

Claims 15-28 are pending. By this Amendment, claims 1-14 are cancelled and claims 15-28 are added. Prompt and favorable action on the merits is respectfully requested.

Respectfully submitted,
FLESHNER & KIM, LLP



John C. Eisenhart
Registration No. 38,128

P.O. Box 221200
Chantilly, VA 20153-1200
703 502-9440 JCE/jgm
Date: June 29, 2001

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JC18 Rec'd PCT/PTO 29 JUN 2001

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1 PLASTIC STRETCHING METHOD AND APPARATUS FOR USE IN VACUUM
2 FORMING TECHNIQUES
3

4 The present invention relates in general to technology
5 for stretching plastic sheets. In particular, the
6 invention relates to the stretching of plastic sheets as
7 a preparation step for use with vacuum forming
8 techniques.
9

10 Vacuum forming techniques are used in a variety of
11 industries; for example, bathroom furnishings such as
12 baths can be vacuum formed from a single sheet of
13 thermoplastic material. The thermoplastic material most
14 commonly used for vacuum forming bathroom furnishings at
15 the present time is acrylic.
16

17 In this manufacturing process, the cost of the
18 thermoplastic sheet represents approximately 70% of the
19 manufacturer's final costs. It would therefore be
20 beneficial to find a method of using less thermoplastic
21 in the manufacturing process. However, if one simply
22 used a thinner sheet, one would expect to produce a final
23 product with reduced mechanical strength.

1 It is therefore an aim of the present invention to
2 provide a method and apparatus for producing vacuum
3 formed goods that uses less thermoplastic than
4 conventional techniques whilst retaining, or even
5 improving, mechanical strength.

6

7 We have found that a thermoplastic sheet, such as an
8 acrylic sheet, which has been stretched before vacuum
9 forming provides a final product which has greater
10 mechanical strength than an unstretched sheet which has
11 the same thickness at the start of the vacuum forming
12 step.

13

14 However, when one considers how to implement this
15 stretching step industrially, a technical difficulty
16 becomes apparent. When a plastic sheet is stretched it
17 will scallop, that is to say that it will narrow in the
18 middle with the sides bowing inwards. This means that it
19 will not have a constant width and thickness throughout
20 and cannot be cut efficiently into smaller square or
21 rectangular portions.

22

23 For example, US Patent No. 5,271,352 to Critical Sciences
24 (Australia) Limited discloses a plastic stretching device
25 for use in vacuum forming boat hulls. This device pulls
26 plastic apart without any means for preventing
27 scalloping. It is therefore impractical to use for any
28 significant amount of stretching.

29

30 PCT/US92/07408 describes a plastic stretching device
31 which has movable clamping means holding all sides of a
32 plastic sheet. However, the edges of the plastic sheet
33 would be unable to expand with the material as a whole,
34 distorting its shape.

JP60049921 to Toyota Jidosha KK goes part of the way to solving this problem by having a plurality of clamps along at least one side of a plastic sheet. However, the movement of each clamps needs individually controlled, leading to a complex and expensive machine.

US3579718 describes an apparatus for stretching sheets of material where there are elongate clamping means which comprise a plurality of movable clamping means. However, although this allows movement of the clamps during stretching, there is no facility to then hold the stretched sheet in place to allow subsequent vacuum forming.

Similarly, US3635640 describes arrangements and methods where the apparatus of US3579718 may be used.

In JP63197626 to Shinto Kogyo KK, a plurality of clamps along opposite sides of a sheet of plastic are controlled automatically by their being mounted on endless roller chains which function to move the sheet of plastic into and out of a heating means as well as holding the plastic sheet. However, when material is stretched by this machine moving the two roller chains apart, the material edges held by the chains are unable to contract proportionately, leading to distortion of the edges and scalloping of the sheet as a whole.

The aim of this invention is therefore to provide a method of stretching plastic sheets which can be used to expand the total surface area of the sheet without distorting the sheet, wasting material or having a non-uniform thickness. In particular, the invention aims to

1 provide a simple controllable mechanism. Furthermore,
2 this invention aims to stretch the plastic sheet in a
3 manner adapted for immediate use in vacuum forming to
4 gain the strength enhancing benefits of the stretching
5 step.

6
7 In this application, the term "plastic" refers to any
8 thermoplastic material.

9
10 According to a first aspect of the present invention
11 there is provided a machine for stretching a rectangular
12 sheet of plastic material, the machine having a first and
13 second orthogonal pairs of opposed elongate clamping
14 means which engagably cooperate with the sides of said
15 sheet and thereby hold said sheet, the machine including
16 a means to controllably urge apart a first pair of
17 opposed elongate clamping means and thereby stretch a
18 sheet held therebetween characterized in that the second
19 pair of opposed elongate clamping means is adapted to
20 allow said sheet to stretch uniformly in a direction
21 parallel to the lengths of the second pair of elongate
22 clamping means whilst resisting movement of the clamped
23 sides of the sheet in a direction orthogonal to the
24 lengths of the second pair of elongate clamping means.

25
26 Preferably, the machine includes means to controllably
27 urge apart both pairs of opposed clamping means and
28 thereby stretch a sheet held therein in two dimensions,
29 each elongate clamping means being adapted to allow said
30 sheet to stretch uniformly in a direction parallel to the
31 length of said individual elongate clamping means whilst
32 resisting movement of the side of the rectangular sheet
33 clamped by said individual elongate clamping means in a

1 direction orthogonal to the length of said individual
2 elongate clamping means.

3

4 The machine may be adapted to stretch the sheet first in
5 one direction and then subsequently in a second direction
6 orthogonal to the first direction.

7

8 Preferably, the elongate clamping means having a
9 plurality of secondary clamps distributed along their
10 length, the secondary clamps engagably clamping a portion
11 of the edge of the rectangular sheet of plastic and being
12 adapted to move along the length of the elongate clamping
13 means proportionately to the stretching of the sheet
14 parallel to the length of the clamping means.

15

16 More preferably, the secondary clamps are moved along the
17 length of the elongate clamping means by the motion of
18 the sheet.

19

20 Preferably, the clamping means have a primary clamping
21 means which engageably and fixedly clamps a side of the
22 sheet of the plastic material.

23

24 Preferably also, the machine has a heating means for
25 evenly heating a plastic sheet held therein.

26

27 According to a second aspect of the present invention
28 there is provided a machine for stretching and vacuum
29 forming a rectangular sheet of plastic comprising a
30 machine for stretching a rectangular sheet of plastic as
31 claimed in any preceding Claim and an engagable vacuum
32 forming means, wherein the engagable vacuum forming means
33 is adapted to vacuum form a rectangular sheet of plastic
34 stretched by the machine for stretching a rectangular

1 sheet of plastic whilst said rectangular sheet of plastic
2 is still held within the elongate clamping means of the
3 machine for stretching a rectangular sheet of plastic.

4
5 Preferably, the machine has a means for selectively
6 cooling zones of the plastic sheet held therein.

7
8 According to a third aspect of the present invention,
9 there is provided a method of stretching a rectangular
10 sheet of plastic material, the method comprising the
11 steps of:

12
13 (a) engagably holding the sides of said sheet; and
14 (b) stretching said sheet along a first axis of said
15 sheet whilst holding the sides of said sheet
16 parallel to the first axis so as to allow the sheet
17 to stretch proportionately along the first axis but
18 so as to resist deformation of the sides of said
19 sheet orthogonal to the first axis.

20
21 Preferably, the method further has the step of:

22 (c) stretching said sheet along a second axis of
23 said sheet whilst holding the sides of said sheet
24 parallel to the second axis so as to allow the sheet
25 to stretch proportionately along the second axis but
26 so as to resist deformation of the sides of said
27 sheet orthogonal to the second axis, the second axis
28 being orthogonal to the first axis.

29
30 Preferably, the method involves, simultaneous to
31 stretching said sheet parallel to a first axis, also
32 stretching said sheet along a second axis of said sheet
33 whilst holding the sides of said sheet parallel to the
34 second axis so as to allow the sheet to stretch

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7

1 proportionately along the second axis but so as to resist
2 deformation of the sides of said sheet orthogonal to the
3 second axis, the second axis being orthogonal to the
4 first axis.

5

6 Preferably, the sides of said sheet are engageably held
7 by a first and second orthogonal pairs of elongate
8 clamping means which each engagably cooperate with a side
9 of said sheet through a plurality of secondary clamps.

10

11 Preferably also, the secondary clamps are adapted to move
12 along the length of the clamping means proportionately to
13 the stretching of the sheet along an axis parallel to the
14 clamping means.

15

16 Most preferably, the secondary clamps wherein the
17 secondary clamps are moved along the length of the
18 elongate clamping means by the motion of the sheet.

19

20 Typically, the method will have the step of heating the
21 sheet of plastic material.

22

23 According to a fourth aspect of the present invention,
24 there is provided a method of stretching and vacuum
25 forming a rectangular sheet of plastic material
26 comprising the steps of stretching a rectangular sheet of
27 plastic according to a method as claimed in any of Claims
28 10 to 16 and then vacuum forming said stretched sheet of
29 plastic.

30

31 Preferably, the edges of said sheet are engagably held by
32 a plurality of primary clamping means before vacuum
33 forming.

34

1 Zones of the plastic material may be selectively cooled.

2

3 An example embodiment of the present invention will now
4 be illustrated with reference to the following figures in
5 which:

6 Figure 1 is a plan view of a plastic sheet
7 stretching machine;

8 Figure 2 is a cross-section through a plastic
9 stretching machine along line AA;

10 Figure 3 is a perspective view of a plastic
11 stretching machine according to the present
12 invention;

13 Figure 4 is a table of results from a Notched Charpy
14 Impact Strength test performed to BS EN ISO 179/1eA-
15 1997; and

16 Figure 5 shows a plan for cutting up sheets of
17 material in a conventional fashion and in a fashion
18 for use with the present invention.

19

20 A plastic stretching machine shown in plan view in Figure
21 1 is intended for use with a rectangular sheet of plastic
22 material or any other vacuum formable material. Elongate
23 clamping means are provided in the form of four clamping
24 bars (1 to 4), one to clamp each edge of the rectangular
25 plastic sheet. Clamping bars 1 and 3 oppose each other,
26 as do clamping bars 2 and 4. Clamping bars 1 and 2 are
27 fixed in place, whereas clamping bars 3 and 4 may be
28 moved, as controlled by a programmable logic controller.

29

30 Each clamping bar 1, 2, 3 and 4 comprises a plurality of
31 secondary clamping means 5 (only some of which are
32 labelled in Figure 1). These clamping means are mounted
33 upon each clamp bar and may move along its length with a
34 low co-efficient of friction.

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1

8

22

30

AMENDED SHEET

1 the plastic sheet is securely held. All four sides are
2 held at once.
3
4 A mould is then driven up through the clamped sheet
5 forming a seal. The mould is then vacuumed by
6 conventional means to form the resulting mould. At the
7 end of this complete product cycle the secondary clamp
8 carriages 5 are returned to their initial positions by
9 the action of the primary clamp bars. A series of
10 linkages prevent the secondary clamps 5 from getting too
11 close to each other.
12

13 Figure 4 shows a perspective view of the combined
14 stretching and vacuum forming machine. In this Figure,
15 conventional vacuum forming apparatus 15 is provided
16 underneath the stretching apparatus. The machine also
17 provides zoned cooling for control of thickness
18 distribution in the final product. This is a technique
19 used in the prior art and cooling apparatus 16 is mounted
20 above the stretching apparatus. An electronic controller
21 17 is provided to allow automation of the procedure.
22

23 The entire process cycle involving both the timings and
24 movements is controlled by a computer or controlled
25 programme logic controller. As a result of this machine
26 it becomes possible to make considerable savings in raw
27 material costs; for example, experiments have indicated
28 that savings of 30% - 50% can be readily achieved. This
29 could not be achieved simply by vacuum forming a thinner
30 sheet of thermoplastic as only the strength benefits
31 provided by the stretching step allow this lower volume
32 of plastic to be used.
33

1 Figure 4 shows a table of results from a Notched Charpy
2 Impact Strength (N.C.I.S.) test performed to BS EN ISO
3 179/1eA - 1997 on samples of 5mm Acrylate Capped ABS
4 taken through the above process.

5

6 In this table, Flexural Modulus tests were performed to
7 BS EN ISO 178 - 1997 at a test speed of 2mm/min. Sample
8 10 test bars were nominally 4mm thick x 10mm wide.
9 Sample 12 test bars nominally 2.3mm thick x 15mm wide.
10 Fallen Ball. All Notched Charpy samples that gave a
11 valid result exhibited a partial break type.

12

13 Figure 5 (a) shows a conventional method for cutting up a
14 sheet of plastic that is 3100mm x 1800mm to form four
15 rectangular pieces 1750mm x 750mm for use in making a
16 product sized 1700mm x 700mm. Note that offcuts are left
17 around the edge. Figure 5 (b) shows how this same sheet
18 can be cut into six rectangular pieces 1550mm x 600mm
19 without offcuts, that may be stretched then used to give
20 a product sized 1700mm x 700mm as before.

21

22 This reduces the time required and the space requirements
23 for storing raw material. Additionally, fewer different
24 sizes of sheet will have to be stocked by a manufacturer.
25 These benefits represent a substantial cut in the cost of
26 manufacturing the product, therefore providing an
27 important commercial advantage.

28

29 It will be clear to one skilled in the art that this
30 technique can be used with acrylic plastic or any other
31 vacuum formable material. Furthermore, this plastic
32 stretching technique will find applications in areas
33 other than just vacuum forming.

34

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12

1 Further modifications and improvements may be
2 incorporated without departing from the scope of the
3 invention herein described.

4
5 Throughout this application, unless the context requires
6 otherwise, the word "comprise" or variations such as
7 "comprises" or "comprising" will be understood to imply
8 the inclusion of a stated integer or group of integers
9 but not the exclusion of any other integer or group of
10 integers.

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13

1 AMENDED CLAIMS

2

3 1. A machine for stretching and vacuum forming a
4 rectangular sheet of plastic material, the machine
5 having a first and second orthogonal pairs of
6 opposed elongate clamping means (1-4) which
7 engagably co-operate with the sides of said sheet
8 and thereby hold said sheet, wherein the elongate
9 clamping means (1-4) comprise primary clamping means
10 (13,14) and secondary (5) clamping means, with the
11 primary clamping means (13,14) engagably and fixedly
12 clamping a side of the sheet of the plastic material
13 and the secondary clamping means (5) engagably
14 clamping a portion of the edge of the rectangular
15 sheet of plastic and being adapted to move along the
16 length of the elongate clamping means (1-4), the
17 machine including a means to controllably urge apart
18 a first pair of opposed elongate clamping means (1
19 and 3) and thereby stretch a sheet held therebetween
20 characterised in that the second pair of opposed
21 elongate clamping means (2 and 4) uses the movable
22 secondary clamping means (5) to allow said sheet to
23 stretch uniformly in a direction parallel to the
24 lengths of the second pair of elongate clamping
25 means (2 and 4) whilst resisting movement of the
26 clamped sides of the sheet in a direction orthogonal
27 to the lengths of the second pair of elongate
28 clamping means (2 and 4), and once the plastic sheet
29 has been stretched the fixed primary clamping means
30 (13,14) are then used to hold the plastic sheet in a
31 fixed position during the vacuum forming process.

32

33 2. A machine for stretching and vacuum forming a
34 rectangular sheet of plastic material as Claimed in

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1 Claim 1, the machine including means to controllably
2 urge apart both pairs of opposed elongate clamping
3 means (1-4) and thereby stretch a sheet held therein
4 in two dimensions, each elongate clamping means (1-
5 4) using the secondary clamping means (5) to allow
6 said sheet to stretch uniformly in a direction
7 parallel to the length of said individual elongate
8 clamping means (1-4) whilst resisting movement of
9 the side of the rectangular sheet clamped by said
10 individual elongate clamping means (1-4) in a
11 direction orthogonal to the length of said
12 individual elongate clamping means(1-4).

13
14 3. A machine for stretching and vacuum forming a
15 rectangular sheet of plastic material as Claimed in
16 Claim 1 or Claim 2, the machine being adapted to
17 stretch the sheet first in one direction and then
18 subsequently in a second direction orthogonal to the
19 first direction.

20
21 4. A machine for stretching and vacuum forming a
22 rectangular sheet of plastic as claimed in any of
23 the previous Claims, wherein the secondary clamps
24 are moved along the length of the elongate clamping
25 means by the motion of the sheet.

26
27 5. A machine for stretching and vacuum forming a
28 rectangular sheet of plastic as claimed in any
29 preceding Claim, the machine having a heating means
30 for evenly heating a plastic sheet held therein.

31
32 6. A machine for stretching and vacuum forming a
33 rectangular sheet of plastic as claimed in any
34 preceding Claim, wherein the vacuum forming means is

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1 engagable and adapted to vacuum form a rectangular
2 sheet of plastic stretched by the machine for
3 stretching a rectangular sheet of plastic whilst
4 said rectangular sheet of plastic is still held
5 within the elongate clamping means (1-4) of the
6 machine by the primary fixed clamping means (13,14).

7
8 7. A machine for stretching and vacuum forming a
9 rectangular sheet of plastic as claimed in any
10 preceding Claim, the machine having a means for
11 selectively cooling zones of the plastic sheet held
12 therein.

13
14 8. A method of stretching and vacuum forming a
15 rectangular sheet of plastic material, the method
16 comprising the steps of:
17 (a) engagably holding the sides of said sheet using
18 movable clamping means (5); and
19 (b) (i) stretching said sheet along a first axis of
20 said sheet whilst holding the sides of said sheet
21 parallel to the first axis so as to allow the sheet
22 to stretch proportionately along the first axis but
23 so as to resist deformation of the sides of said
24 sheet orthogonal to the first axis; and
25 (c) fixedly holding the sides of said stretched
26 sheet using fixed clamping means; and
27 (d) vacuum forming said stretched sheet.

28
29 9. A method of stretching and vacuum forming a
30 rectangular sheet of plastic material as claimed in
31 Claim 8, the method further having the step of:

32
33 (b) (ii) stretching said sheet along a second axis of
34 said sheet whilst holding the sides of said sheet

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16

1 parallel to the second axis so as to allow the sheet
2 to stretch proportionately along the second axis but
3 so as to resist deformation of the sides of said
4 sheet orthogonal to the second axis, the second axis
5 being orthogonal to the first axis.

6
7 10. A method of stretching and vacuum forming a
8 rectangular sheet of plastic material as claimed in
9 Claim 8, the method involving, simultaneous to
10 stretching said sheet parallel to a first axis, also
11 stretching said sheet along a second axis of said
12 sheet whilst holding the sides of said sheet
13 parallel to the second axis so as to allow the sheet
14 to stretch proportionately along the second axis but
15 so as to resist deformation of the sides of said
16 sheet orthogonal to the second axis, the second axis
17 being orthogonal to the first axis.

18
19 11. A method of stretching and vacuum forming a
20 rectangular sheet of plastic material as claimed in
21 Claim 8 wherein the secondary clamps are adapted to
22 move along the length of the elongate clamping means
23 (1-4) proportionately to the stretching of the sheet
24 along an axis parallel to the clamping means.

25
26 12. A method of stretching and vacuum forming a
27 rectangular sheet of plastic material as claimed in
28 Claim 11 wherein the secondary clamps are moved
29 along the length of the elongate clamping (1-4)
30 means by the motion of the sheet.

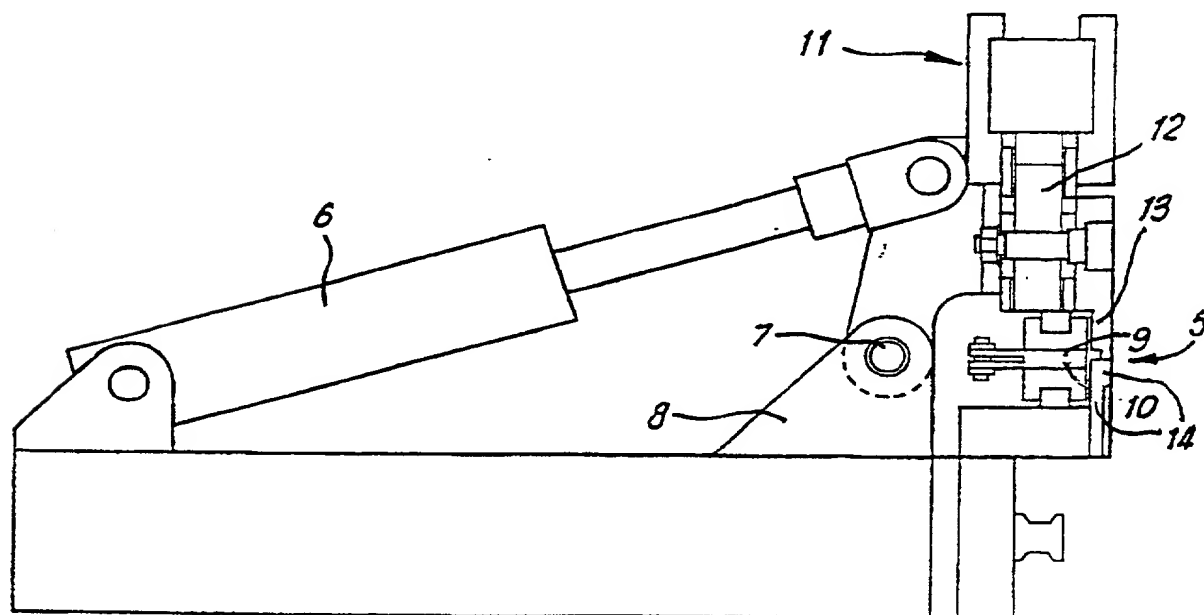
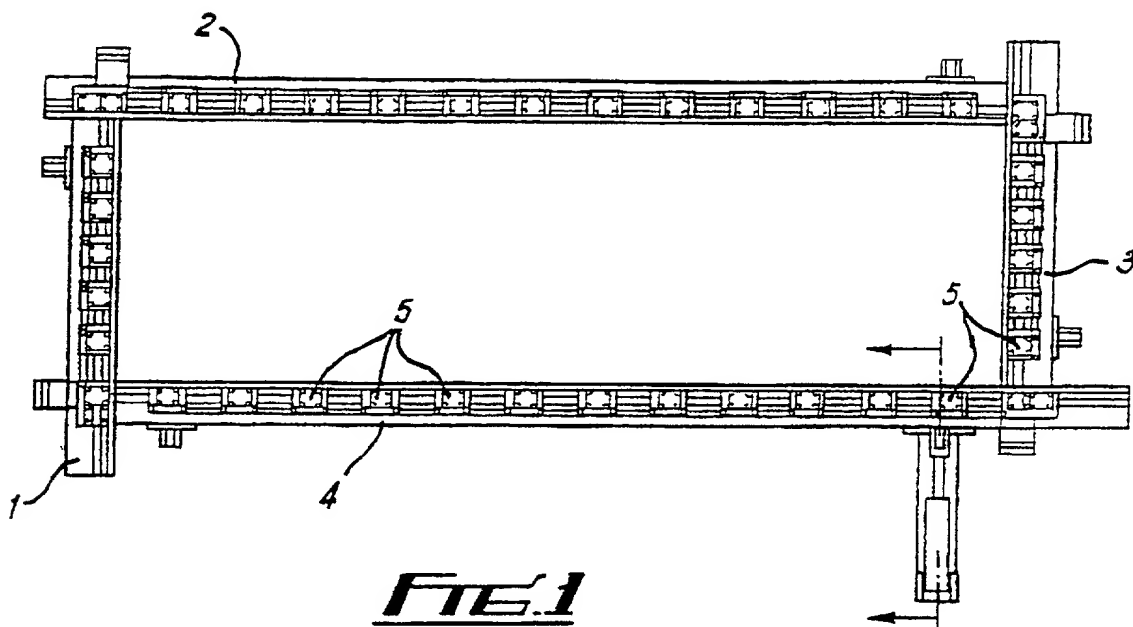
31
32 13. A method of stretching and vacuum forming a
33 rectangular sheet of plastic material as claimed in

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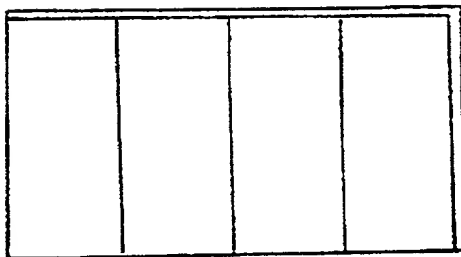
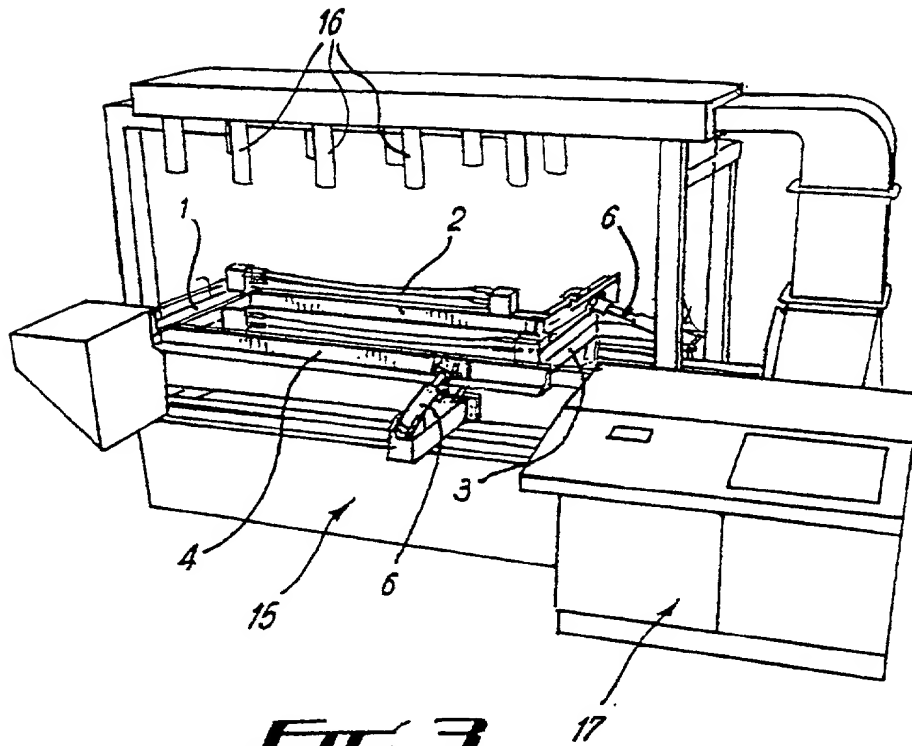


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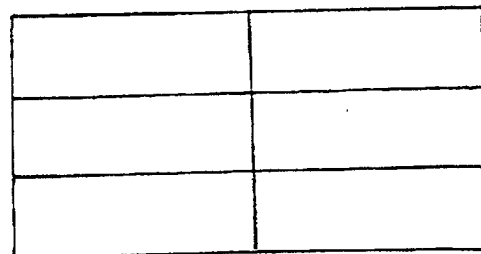
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FTE.5a

FTE.5b



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Material	Sample Number	N.C.I.S @ 23°C (kJ / m ²)	Flexural Modulus (MPa)
12	1	NB	1340
	2	NB	1380
	3	NB	1370
	4	NB	1410
	5	NB	1400
	6	NB	---
	7	83	---
	8	NB	---
	9	NB	---
	10	NB	---
	mean	N/A	1380
	σ_{n-1}	N/A	28

Material	Sample Number	N.C.I.S @ 23°C (kJ / m ²)	Flexural Modulus (MPa)
10	1	87	1250
	2	85	1240
	3	85	1250
	4	83	1280
	5	88	1250
	6	85	---
	7	88	---
	8	84	---
	9	84	---
	10	86	---
	mean	85	1250
	σ_{n-1}	1.2	7

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FIG. 4

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TO:01412266838

P:4

Prior US/PCT Applications:

(US Application Serial No)

(US Filing Date)

(Status-patented/pending/abandoned)

(US Application Serial No)

(US Filing Date)

(Status-patented/pending/abandoned)

(PCT Application No)

(US Filing Date)

(US Serial No
Assigned, if any)

(Status-patented/pending/abandoned)

(PCT Application No)

(US Filing Date)

(US Serial No
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(Status-patented/pending/abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that wilful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such wilful false statements may jeopardize the validity of the application or any patent issued thereon.

POWER OF ATTORNEY: I hereby appoint the following attorney(s) and/or agent(s): Daniel Y J Kim, Registration No 36,186 and Mark L Fleshner, Registration No 34,594; Carl R Wesolowski, Registration No 40,372, and John C Eisentratt, Registration No 38,128, all of

Address all telephone calls to:
Address all correspondence to:

(703) 502-9440
FLESHNER & KIM
PO Box 221200
Chantilly
VIRGINIA 20153-1200, USA

with full power of substitution and revocation to prosecute this application and to transact all business in the Patent and Trademark Office connection therewith, and all future correspondence should be addressed to them.

Full name of sole or first inventor:Iain Preston**Inventor's Signature:**Iain Preston**Date:**21. 6. 01**Residence**4 North Approach Road, KINCARDINE ON FORTH, FK10 4NL, United KingdomGBX**Country of Citizenship**United Kingdom**Post Office Address**4 North Approach Road, KINCARDINE ON FORTH, FK10 4NL, United Kingdom

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22-JUN-2001 10:19 GORDON HALL

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JUN-2001 15:06 FROM:PRESTON ASSOC 01259731434

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Full Name of second joint inventor, if any

Gordon Hall

Inventor's Signature



Date

22/6/2001

Residence

4 North Approach Road, KINCARDINE ON FORTH, FK10 4NL, United Kingdom

GBX

Country of Citizenship

United Kingdom

Post Office Address

4 North Approach Road, KINCARDINE ON FORTH, FK10 4NL, United Kingdom

Full Name of third joint inventor, if any

Inventor's Signature

Date

Residence

Country of Citizenship

Post Office Address

Full Name of fourth joint inventor, if any

Inventor's Signature

Date

Residence

Country of Citizenship

Post Office Address

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